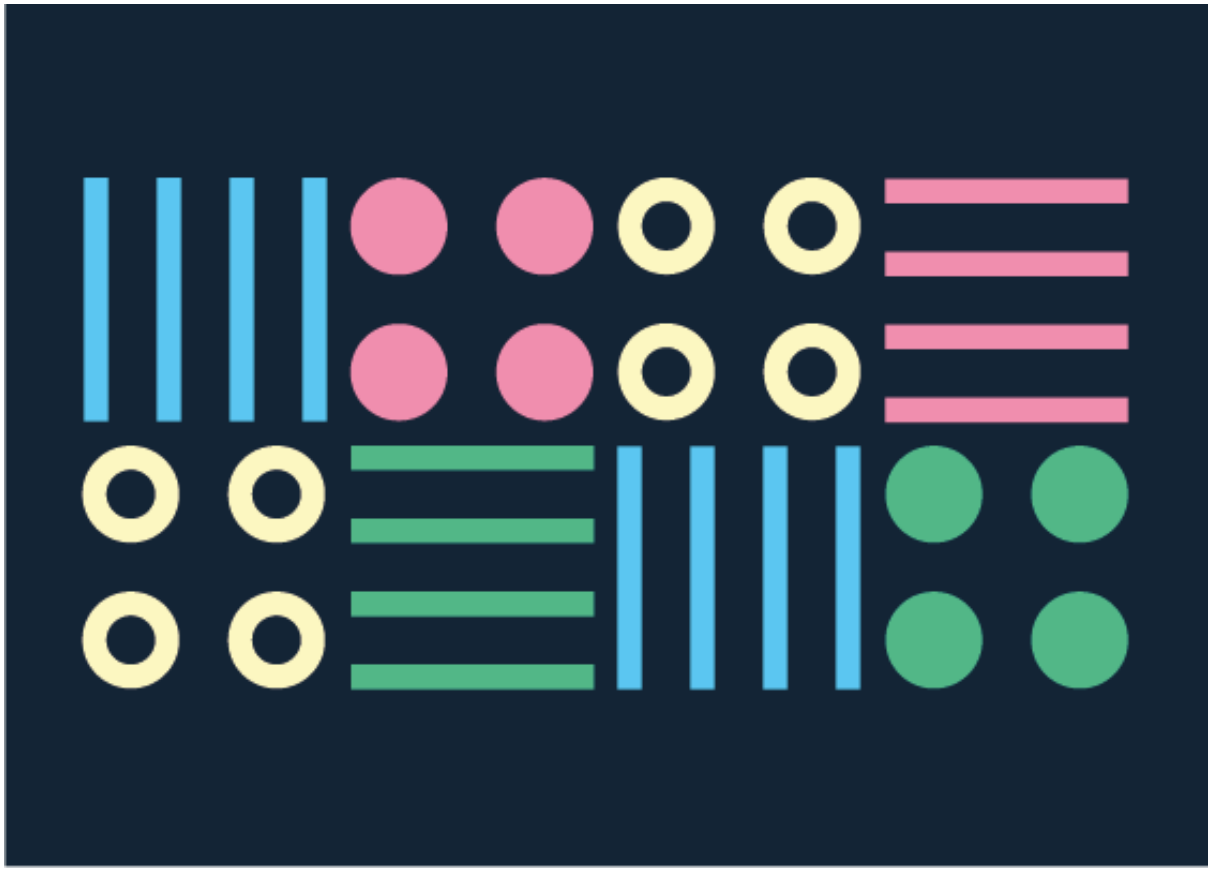
Needs and Demand Report



LCR4.0

Together for Manufacturing.

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January 2017 - Final

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1. Introduction and Objective

LCR 4.0 is a partnership between the University of Liverpool, Liverpool John Moores University, Liverpool City Region LEP, Sensor City, Virtual Engineering Centre and Hartree Centre. The project brings together key assets with the skills and expertise to support industrial growth, merging the virtual and physical world to ultimately transform modern manufacturing and associated supply chains.

The project has been developed to address DCLG's call for support under ERDF Priority Axis 1, Promoting Research and Innovation with the aim to promote business investment in research and development – developing links and synergies between enterprise, research and development centres and Higher Education sector, in particular promoting investment in product and service development, technology transfer, social investment, eco innovation, public service applications, demand stimulation, networking, clusters and open innovation through smart specialisation; and supporting technological and applied research, pilot lines, early product validation actions, advance manufacturing capabilities and first production, in particular in key enabling technologies and diffusion of general purpose technologies.

In modern global manufacturing, industrial leaders are ever increasing the need to innovate and adopt new technological advances to remain competitive.

Industry 4.0, the 4th Industrial Revolution, is a concept that is becoming increasingly familiar and focuses on digitisation of physical assets and integration into digital eco-systems with value chain partners. Ultimately, this hinges on the generation and analysis of data to create value.

LCR 4.0 is a transformational support project which will address the forthcoming challenges facing the manufacturing sector, providing businesses with the opportunity to develop smarter products, processes and supply chains to increase productivity.

To ensure the project delivers services that meet the needs of organisation who are seeking to increase productivity, a number of actions have been taken in order to gather information for this report and include:-

- June 20th 2016, Insider Magazine reported "Gaping hole in Industry 4.0 Knowledge" *Just 8% of manufacturers in the UK have a significant understanding of Industry 4.0 processes despite almost three fifths recognising that the "fourth industrial revolution" will have a big impact on the sector, a new study has found.* LCR 4.0 hosted a Roundtable Debate in response to the article on 27 July 2016
- Between July - October 2016 a survey was published via the Growth Hub to businesses across the region
- During July – October 2016 Individual interviews were held by the partners with businesses
- The launch of LCR 4.0, 30th November 2017 provided an opportunity for the region to discuss their thoughts of what Industry 4.0 means to them
- Additional research included reports by EEF "The 4th Industrial Revolution: A Primer for Manufacturers"; Institute of Mechanical Engineers "Industry 4.0 Report"; Friedrich Ebert Stiftung "The Challenges of Industry 4.0 for Small and Medium-sized Enterprises"

To remain competitive in the global market, the UK needs to stop talking about Industry 4.0 and start implementing it. LCR 4.0 is the first step in making that happen in Liverpool City Region.

2. Roundtable

In order for the UK to compete on a global level and keep up with the rest of the world, manufacturers must grasp the opportunities presented to them by Industry 4.0. To explore this topic a special roundtable debate was held to discuss what the current understanding of Industry 4.0 is among digital manufacturers in the Liverpool City Region and where the biggest challenges and opportunities lie.

a) Attendees

Anthony Walker, Strategic Manager LCR 4.0, Liverpool John Moores University

Simon Reid, Sector Manager, Advanced Manufacturing, Liverpool City Region Local Enterprise Partnership

Gillian Murray, Director, Virtual Engineering Centre

Peter Salt, General Manager, Immersive Interactive

Jon Hague, Vice President of Operations & Open Innovation, Unilever

John Hopkins, Chief Executive, Med eTraX

Luke Walsh, Managing Director, Brainboxes

Tom Dawes, Valuechain.com

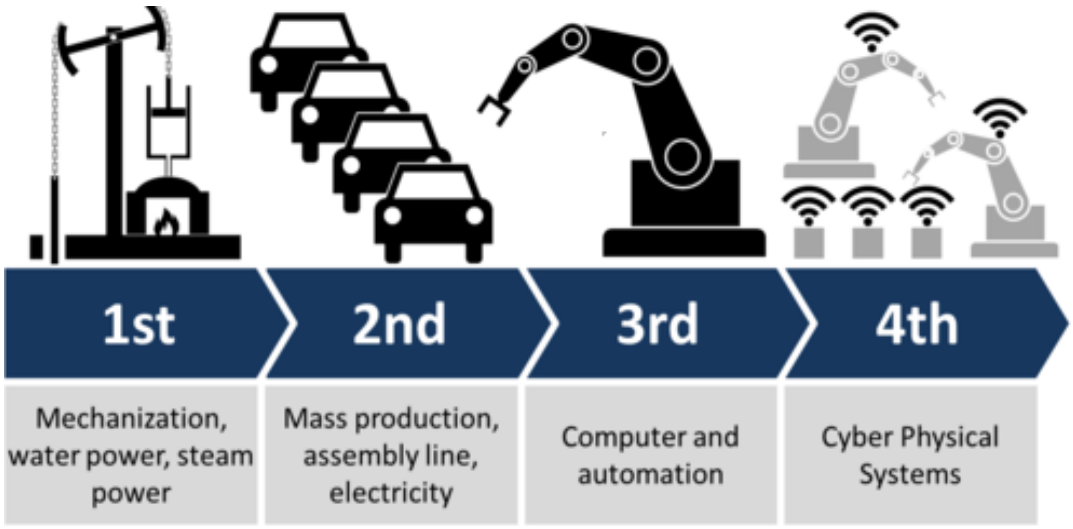
Jonathon Shaw, Chief Engineer, Digital Manufacturing, Manufacturing Technology Centre

b) Objectives

The intelligence of things

Consultants at McKinsey define Industry 4.0 as the "fourth major upheaval in modern manufacturing". It follows 'lean' in the 1970s, outsourcing in the 1990s and more automation which characterised manufacturing in the 2000s. Industry 4.0 is driven by four disruptions including increased data volumes, emergence of new analytics capabilities, new human-machine interactions and improvements in transferring the digital into the physical world, using technology such as 3D printing.

With increased productivity, better data analysis, increased competitiveness and lower manufacturing costs touted as the top ways in which Industry 4.0 will affect UK manufacturing, the roundtable looked into how the region's manufacturers take full advantage of the possibilities and what challenges they faced.



c) Observations and Recommendations

In modern global manufacturing, industrial leaders are ever increasing the need to innovate and adopt new technological advances to remain competitive.

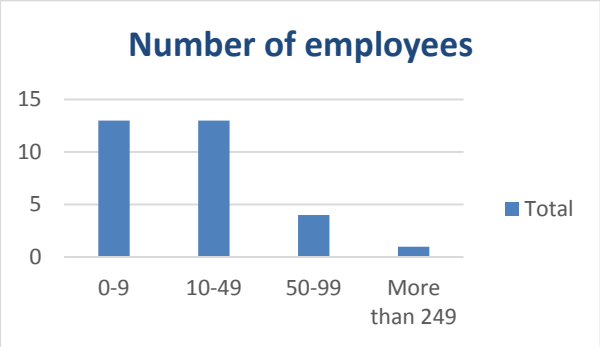
Industry 4.0, the 4th Industrial Revolution, is a concept that is becoming increasingly familiar and focuses on digitisation of physical assets and integration into digital eco-systems with value chain partners. Ultimately, this hinges on the generation and analysis of data to create value.

The term Industry 4.0 has been talked about for a couple of years, but what does it actually mean to modern manufacturing enterprises? Most companies accept there will be benefits using smarter analytical tools to stimulate competitiveness and lower manufacturing costs, but the situation remains that a large number of companies (particularly SMEs) simply do not know how they will implement such changes to reap the rewards.

3. **Survey**

The survey was originally published to businesses via the LCR LEP Business Growth Hub network in July 2016, however the initial response was extremely poor and partners were asked to share the survey with their own networks. The deadline was extended a number of times due to the lack of response and finally closed on 28th October 2016 with only 31 businesses participating in the survey.

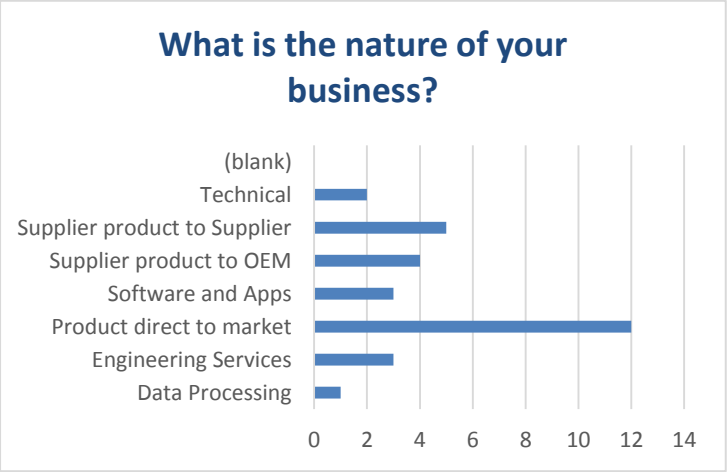
The first section of the survey was to categorise the type of businesses responding.



Of those 31 businesses 41.9% had less than 9 employees, another 41.9% had between 10 and 49 employees, 12.9% had 50-99 employees and only 1% did not fall within the definition of an SME and had more than 249 employees.

The majority of businesses had been trading for over 10 years and none were new business start-ups, all had been trading for more than 12 months.

All the businesses were based in the Liverpool City Region, with the highest number actually based in the Liverpool area.

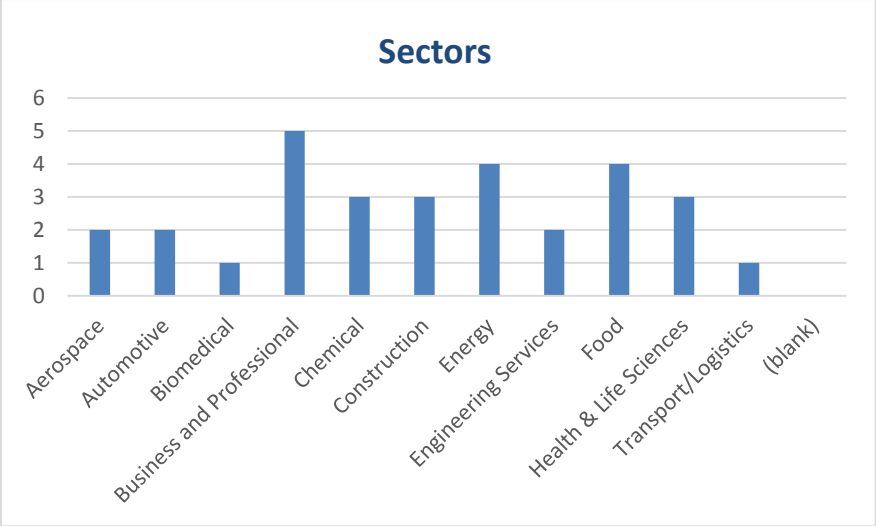


Of the 21 categories provided to describe the type of business, only 7 categories were identified as the nature of their business, Supplier product to OEM; Supplier product to Supplier; Product direct to market; Engineering services; Software and Apps; Data Processing and Technical.

The options to describe the nature of the business included:-

- Supplier Product to OEM
- Supplier Product to Supplier
- Product direct to market
- Prototyping
- Testing/Validation
- Engineering Simulations
- Maintenance
- Product Design
- Tooling
- Machine Efficiency
- Digital Infrastructure
- Cloud Technology
- Software and Apps
- Virtual/Augmented Technology
- Integrated System
- Data Processing
- Cyber Security
- Technical

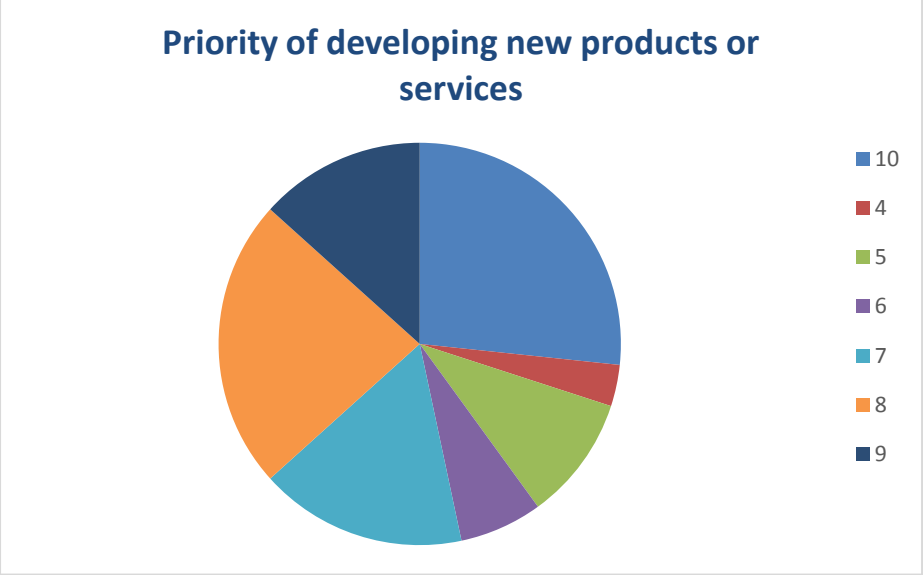
The highest percentage of businesses that participated in the survey stated that they worked in the Business and Professional sector (16.7%), second highest was for the Energy (13.3%) and Food (13.3%) sectors. None stated that they worked in the Marine sector, Transport/Logistics (3.3%) and Biomedical (3.3%) were the next lowest and interestingly only 6.7% of the businesses stated that they worked in each of the following key sectors Automotive, Aerospace and Engineering Services, with 10% working in each of the Chemical, Construction and Health & Life Sciences sectors.



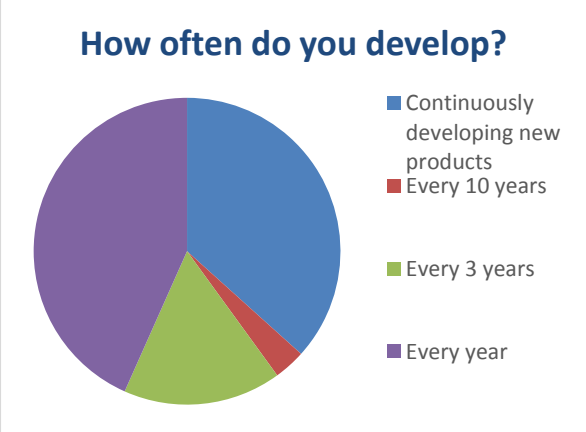
Businesses were asked to choose what they would like to do in their business:-

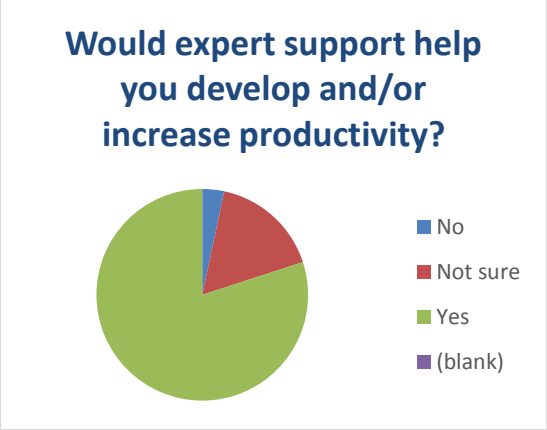
- Increase efficiency = 16.7%
- Increase productivity = 14.1%
- Reduce costs = 10.3%
- Develop an idea = 10.3%
- Improve existing products = 15.4%
- Develop a new product = 14.1%
- Develop a new process = 5.1%
- Strengthen your position in the supply chain = 14.1%

The businesses rated the priority for developing new products or services with 1 being the lowest priority and 10 the highest.

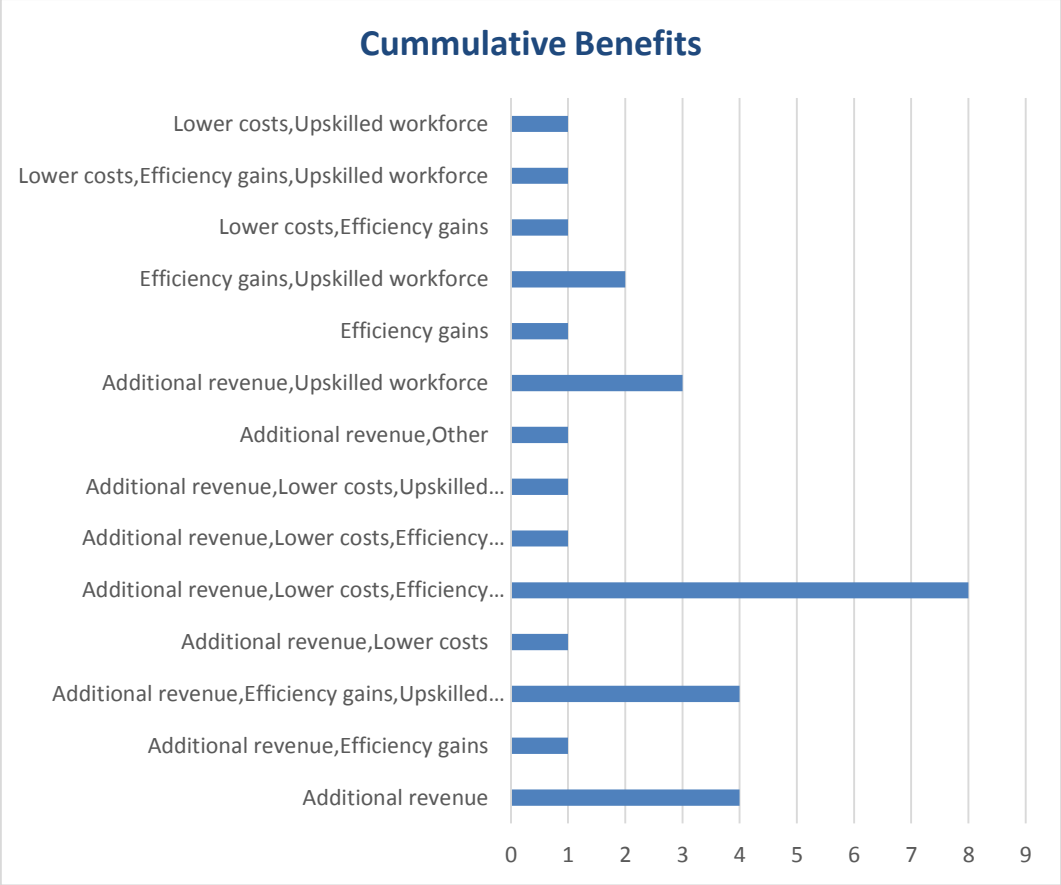


We asked how often businesses aimed to develop products and if expert support would help them to develop and/or increase productivity.





If the business received expert support it expected the following cumulative benefits in the next 5 years:-



Businesses identified the top 5 support themes that they feel would be beneficial to their business, Funding and Investment are clearly the most important.

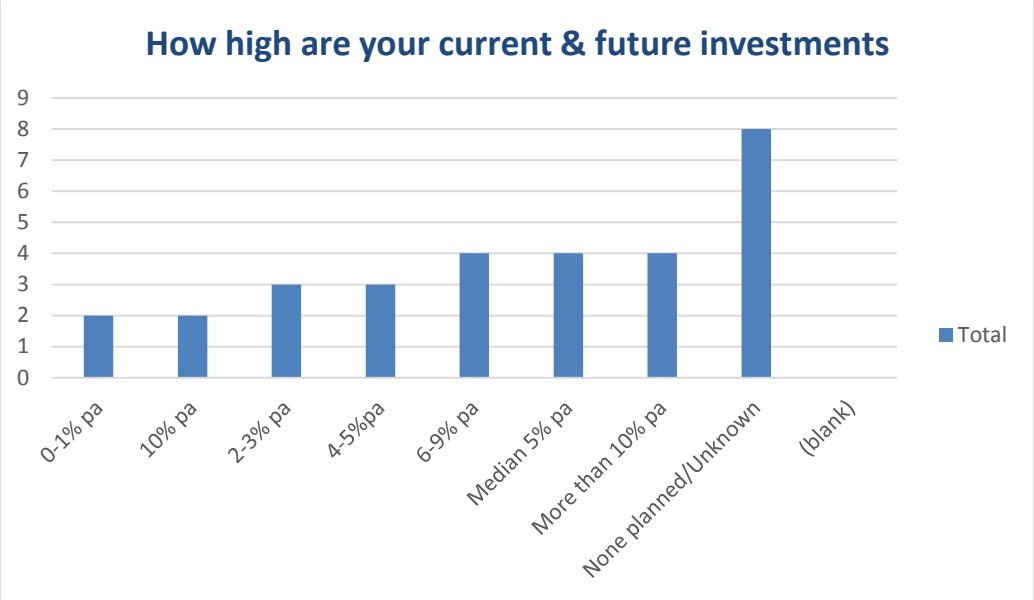
- Virtual Prototyping (3.9%)
- Product Development (10.2%)
- Testing (5.5%)
- Validation (3.9%)
- Access to facilities (5.5%)
- Innovation Plans (4.7%)
- Funding Investment (16.5%)
- IP Support (2.4%)
- Strategic Support (7.1%)
- Business Plans (7.9%)
- Supply chain development
    - Automotive (3.9%)
    - Aerospace (3.1%)
    - Chemical (2.4%)
    - Food (2.4%)
    - Other (1.6%)
- Enhanced support (1.6%)

- Coach/Mentor (3.9%)
- Leadership (4.7%)
- Higher skills (5.5%)
- Sustainability Plan (3.1%)

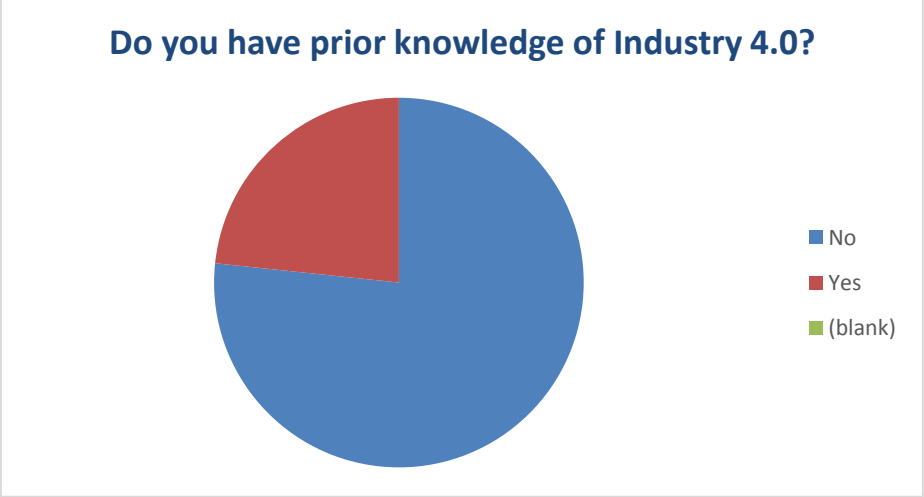
There are various challenges and barriers that businesses face when trying to develop new products and be innovative, namely Funding Investment (22.2%) and skills (13.3%). Other barriers include:-

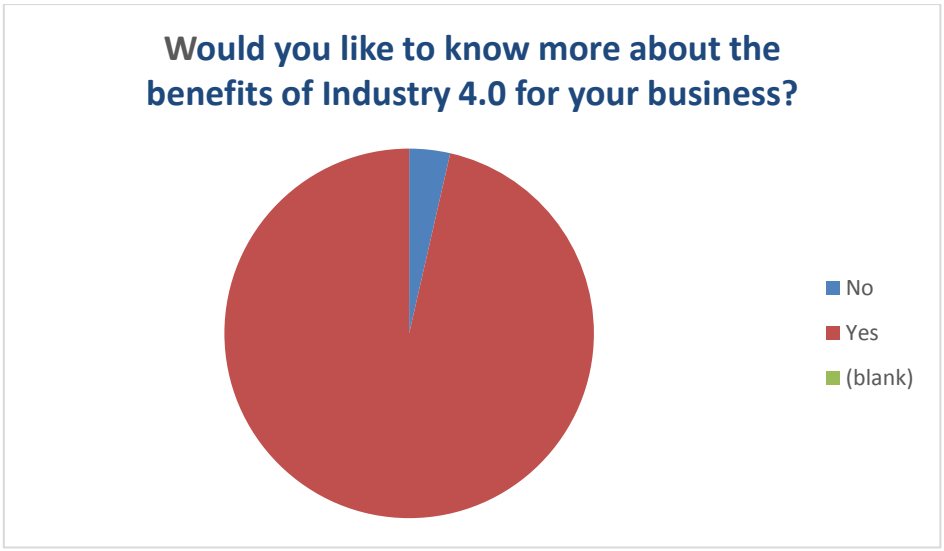
- Lack of clear vision and support/leadership (4.4%)
- Unclear economic benefit from investments (5.6%)
- Finding the right partners for development (10%)
- Lack of external support (5.6%)
- Timescales (7.8%)
- Lack of knowledge (4.4%)
- Concerns around loss of control of your IP (3.3%)
- Testing/Validation of prototype/product (6.7%)
- Access and knowledge of market (10%)
- Exploitation/Commercialisation strategies (5.6%)
- Workforce development (1.1%)

How important is it for businesses to have a strategic vision and plan? 25.4% of the businesses have a Business Plan in place, 18.6% have a Business Growth Plan, 18.6% a Marketing Strategy, 15.3% have an Innovation Strategy and 8.5% have a Change Management Process in place. 13.6% have no plans or strategies in place. How much does a business want to invest in it future and how much resources are they prepared to invest in solutions to problems?



LCR 4.0 aims to support SME's to be in a position to adopt new digital technologies and be part of the 4th industrial revolution. We asked businesses about how we can assist them.




Would you like to know more about the benefits of Industry 4.0 for your business?
No
Yes
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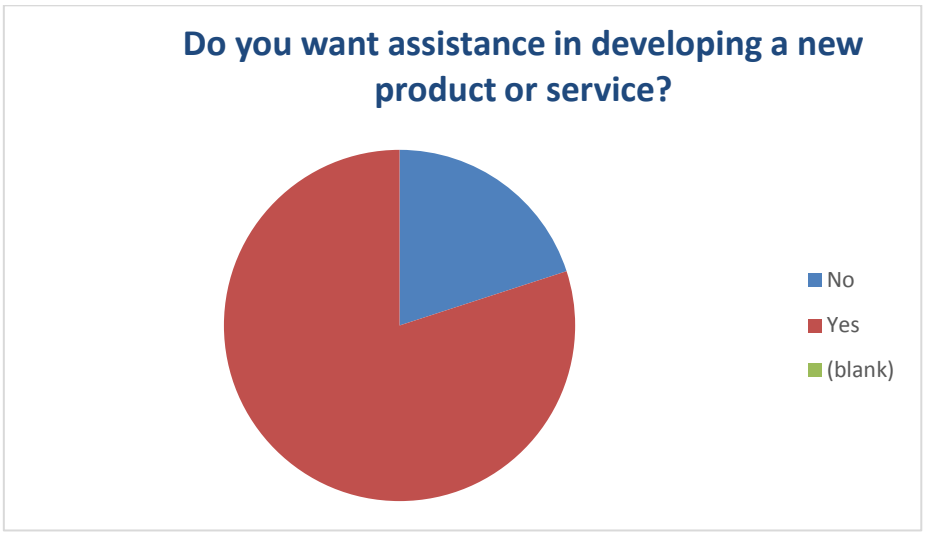
Do you want assistance in developing a new product or service?
No
Yes
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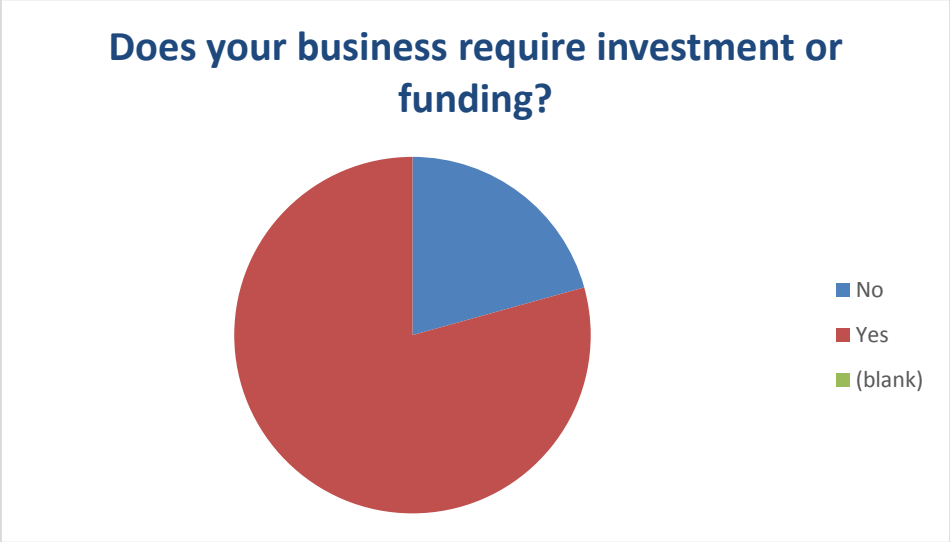
Would you like to improve your position and relationship within the supply chain?
No
Yes



It appears that the majority of businesses do not know what Industry 4.0 is and how it impacts on their business, they would like to find out more about how it can increase productivity and how they can adopt those technologies for the benefit of the business. They would like to be innovative and develop new products and processes, they are looking to improve their current products/services and acknowledge that they need to invest in their business, although they will need support in this and be a major player in the supply chain to increase productivity.

4. **Interviews**

Each partner undertook a series of interviews with a selection of businesses, the transcripts can be read in Appendix 2.

In summary, the businesses interviewed are aware of that to stay competitive they need to be innovative in their approach to products, processes and their businesses. However, they all said expert support is key for them to invest resources into their ideas.

There is a lack of knowledge of Industry 4.0 and the businesses would be keen to find out what it means to them.

5. Launch

At the launch of LCR 4.0 a selection of business representative including Luke Walsh, Brainboxes; Tom Dawes, Valuechain; Jonathan Hague, Unilever; Steve Warren EEF and Simon Reid LCR LEPs were asked what Industry 4.0 meant to them. Innovative SMEs will be critical to the success of the next industrial revolution which is transforming the manufacturing sector.

This latest evolution of the manufacturing sector offers opportunities for companies to increase productivity, respond more quickly to customers' needs and grow sustainably. This is achieved through the adoption of technologies that enable increased connectivity between digital and physical assets.

Steve Warren, region director (North West) at EEF, one of the key note speakers at the LCR 4.0 launch, called on businesses to drive innovation from the top down and integrate IT departments into board level decisions.

Simon Reid, sector manager for advanced manufacturing at the Liverpool City Region LEP, said: "SMEs have to want to innovate and for some this could mean a major culture change is required.

"There can be an attitude that embracing new digital technologies is something for big businesses, not SMEs, but if they don't they could get left behind as the industry continues to evolve in order to meet customers' expectations.
"In Liverpool we are in lucky that we have world class technical and knowledge assets on our doorstep that can give SMEs the support they need to find out what opportunities are available for their business."

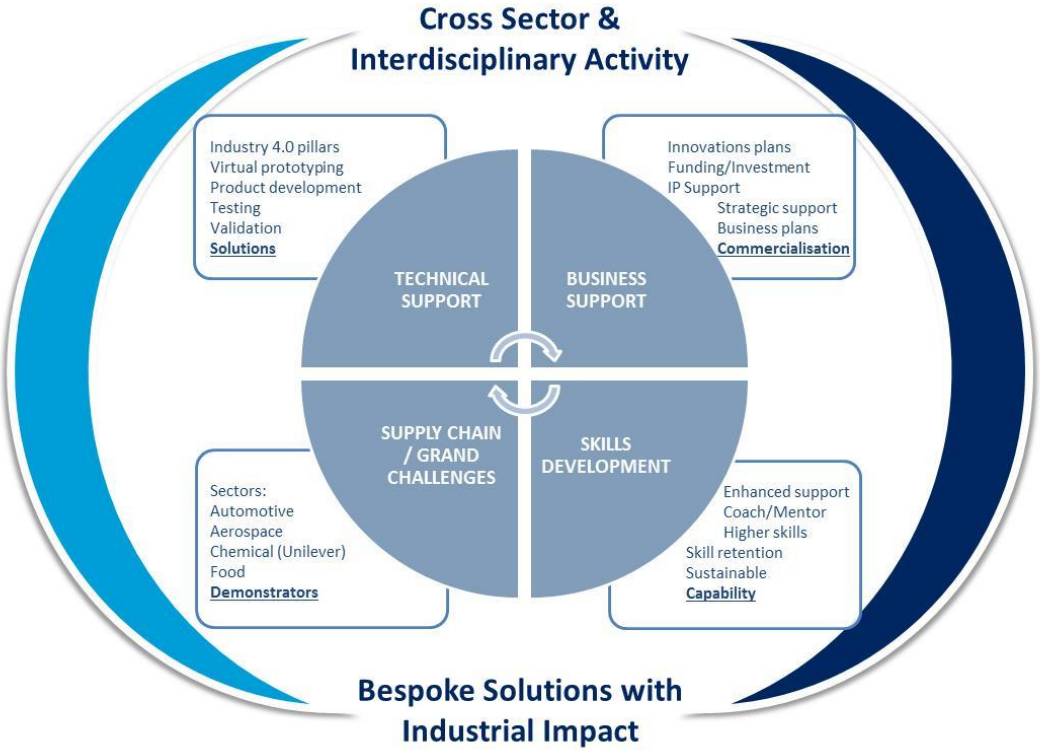
"The focus can't just be on manufacturers though," added Simon. "We need innovators to come forward and provide the technologies which are going to help our local businesses to continue to compete nationally and internationally.
"We have a strong digital community in the region which we should tap in to if we are to see our manufacturers upskill and adapt to embrace new ways of working."

6. Conclusions

To address this challenge, key assets in Liverpool City Region have come together to develop LCR 4.0 – a transformational innovation support project to help SMEs utilise Industry 4.0 technologies to increase productivity in local companies by supporting the development of smarter products, smarter processes and smarter supply chains. This project aims to be the first of its type in the UK, to actually help companies implement new technological developments and fully embrace the benefits that Industry 4.0 will bring.

LCR 4.0 is a partnership between the University of Liverpool, Liverpool John Moores University, Liverpool City Region LEP, Sensor City and Hartree Centre. The project brings together key assets with the skills and expertise to support industrial growth, merging the virtual and physical world to ultimately transform modern manufacturing and associated supply chains.

The time for talk is over, the time for action is now. To remain competitive in the global market, the UK needs to stop talking about Industry 4.0 and start implementing it. LCR 4.0 is the first step in making that happen in Liverpool City Region.



A number of cluster groups will be set up to focus on the needs of the SME's in the Liverpool City Region and help them adopt new technologies, develop new products, processes and strengthen their position in the supply chains, becoming more competitive and increasing productivity.

Appendix 1

Roundtable Debate Participants comments:

Anthony Walker, Strategic Manager, LCR 4.0, LJMU

"My vision of Industry 4.0 is the impact it will have on productivity by developing smarter products, smarter processes and faster supply chains. That will stimulate economic growth.

One of the pillars of Industry 4.0 is cyber security. So if you're looking to create more autonomy and digitise the supply chain, your IP (intellectual property) could be held in the cloud. Are you comfortable with that? Cyber security is massive challenge to any process of digitisation.

SMEs are telling us that they have jobs but they can't find the right people without having to train them up for a long time. From the university perspective we're striving to create industry-ready graduates and we're developing an MSc around digital manufacturing, for example. But we're just one university, we can't do it all on our own. We are looking to partner with people who will enhance the curriculum and bring industrial input into the skills side. I'd also like to address the silo mentality culture within companies. Staff are scared of new technologies; people are terrified of Industry 4.0 as they think it will replace all the staff with automatic systems. But it won't; what it will do is upskill staff. Companies need to change culture and understand the benefits."

Simon Reid, sector manager, advanced manufacturing, Liverpool City Region Local Enterprise Partnership

"Together with our university colleagues, we see Industry 4.0 as driving innovation, productivity, growth and further jobs and investment. Industry 4.0 is an evolutionary curve for businesses. At a very fundamental level, productivity improvements can be driven through better use of data and analysing process and procedures. At the other side of the scale is full servicisation of that manufacturing business. If I were to distil a definition of Industry to a sentence, it would be where the Venn diagram of the cyber and the physical meet.

We went on an Industry 4.0 fact-finding mission to Germany and visited Siemens' national training centre in Berlin. They are taking their16 to 18-year-olds through what used to be a mechatronics apprenticeship into what's now a mechatronics and IT apprenticeship. They are now looking at how mechanical

and electrical properties interact with the digital world. I visit colleges and schools in the UK and they are doing some great science projects, but their IT students are doing completely different things. I always ask whether there are any projects where the IT, mechanical and electronic engineers can collaborate.

At the LEP we have to grab the opportunity of Industry 4.0. Using European funding there's a programme called LCR 4.0 to proactively go out to companies through the Growth Hub and take the Industry 4.0 message to the boardrooms in the Liverpool City Region. We can show them the potential productivity gains, the potential new markets, the export opportunities and new partnerships that could be formed and to help de-risk it for them with European money to pump-prime that sandpit.

The CBI found that if the UK manufacturing supply chains could share data, that's £149bn worth of efficiencies. It's a big prize."

Gillian Murray

"Industry 4.0 is the embodiment of modern manufacturing; you can align a lot of tools, techniques and innovations to it. We help companies become more productive by using advanced modelling, simulation and digital engineering tools and techniques, which is often the first step on the Industry 4.0 journey.

The biggest challenge is the breadth of it and where an organisation starts in order to add value. Another challenge is the pace of change in technology. It's difficult for companies to keep up. So we have a sandpit approach, allowing companies to play with the technology. We take companies on an innovation journey. The Bentley project [which was a winner at Insider's Made in the North Awards 2016] is a great example. We started helping them to design cars quicker and less expensively. Then we looked at how we manufacture them better. All the partners came together to explore how we can work together and deliver the right tools and toolsets back to the business. These pilot projects, or sandpits as we like to call them, are really important. They allow you to deliver something that's critical to the business, see the return on investment, and capture it from future budgets in order to invest for the long-term."

Peter Salt, general manager, Immersive Interactive

"We're a company that produces software for interactive sensory room for the education and medical sectors. We've got to a point where we're ahead of the curve in terms of our competition, but we've got to make sure we stay ahead

and develop. We've got to move more into 3D and we're working with Liverpool John Moores looking into bringing in graduates to go on placement with us for 3D modelling and software development.

However, we know that if we take a graduate on using a knowledge transfer partnership that the graduate will grow with the company and become very marketable. That could lead to a problem with IP—especially if all the IP is developed by one person.

One of the biggest frustrations I have at the moment is developing our overseas market. We have to supervise the build of our immersive rooms at the moment. We want to try to set up a reseller network that will enable us to focus less on the physical build, and concentrate on the software. If we can do that, we can transform the company quickly. Our tie-up with John Moores is about getting the software content to stay ahead of the game."

Jon Hague, vice president of operations & open innovation, Unilever

"Industry 4.0 is the transformation of manufacturing industries with digital technologies. The important word is transformation, which by definition affects all elements of the product lifecycle. As well as economic productivity, environmental productivity should be a great outcome of Industry 4.0. We should be able to use resources much more effectively.

At Unilever, want to digitise our research and development and we'd love to be in a position where for the products we make – fast-moving consumer goods – we don't make anything that we don't sell.

We want to be able to predict how a product will behave with consumers, what packages are going to do – whether they are going to leak, for example; how will they behave in the supply chain; all in silico rather than the physical prototyping and testing that we have to do now. The most obvious benefit is, and the one we're interested in, is speed. But you can also see knock-on impacts on quality and manufacturability.

We've got more than 250 factories around the world and approximately 400 co-manufacturers. There are all those assets already out there making Unilever products and if we wanted to transform all of our manufacturing capabilities to Industry 4.0, how on earth do we do that? I don't know if people have really figured out how to retrofit and digitise old assets, but that will be our big challenge. We will build factories of the future, of course, and we have a couple of projects on the go, but that's just two out of hundreds that are on the ground

already manufacturing. We've got to look at what we've already invested in and how that becomes part of Industry 4.0 as much as what the future is going to be.

Another challenge with bringing more autonomy into a business is 'idleness'. If you have autonomous factories and autonomous knowledge work, what's in it for people? Industry 4.0 has to paint a scenario of the future that does generate employment otherwise how does value get created? By 2030, when we've gone through the transformation curve, what will the workplace look like?"

John Hopkins, chief executive, Med eTraX

"What does industry 4.0 mean to us? For me it's about the growth of the business and the area and bringing more employment to Liverpool.

Health is a people industry and we produce a product that if implemented has huge return on investment in making clinical staff more efficient. But the pace of change in the NHS and its appetite of perceived risk make it difficult for us. The data we produce from our type of product can start to produce datasets of a predictive nature that will help the diagnostic path. That will see us move towards personalised medicine and delivering care when it's needed.

As we develop software for the health service, one of the challenges we have, as we explore the sensor technology route to feed into our products, is getting well qualified people who understand the health sector and its challenges and the electronics of sensor technology. We're working closely with LJMU and Alder Hey, pulling in the sensor knowledge and the clinical knowledge and marrying those two aspects together to deliver benefit. We require a good pool of talent."

Luke Walsh, managing director, Brainboxes

"Many SMEs are far behind when it comes to technical capabilities. I think the challenge is making SMEs understand they don't need new machines they can make existing ones more efficient. There's inertia, people are used to what they've got. I'm sure large blue chip companies will embrace Industry 4.0, but the challenge is allowing SMEs to make the transition as well.

When it comes to the internet of things, I would be very careful of what you put on the internet. Initially you may not need that internet connection to benefit from what Industry 4.0 has to offer. There's very little appreciation for cyber security and what the impact could be if someone got hold of your information.

Someone could build a very detailed picture of your organisation, and if they can see things, they may be able to control things too."

Tom Dawes, Valuechain.com

"For me the definition of Industry 4.0 is about product lifecycle, value chain integration, innovation and intelligence. It depends on what sector and what tier you're in. If you're an OEM (Original Equipment Manufacturer) you're looking at product innovation and some process innovation. If you're a supplier, it's all about process innovation as you won't have much control over product development.

Industry 4.0 is also about capturing intelligence – from people, parts, processes or partners in the supply chain. It's about analysing the data, and how you visualise and use that data to make more informed decisions.

The big challenge is people; it's a new generation of graduates that we need with operations management skills, electronic engineering, software engineering and data science. Getting data is relatively straightforward, being able to interpret it to make valuable, informed decisions, is important.

There are also cultural issues around supply chain collaboration—customers and suppliers sharing data more openly. There's no point having a smart factory if you're scuppered by your supply chain and you've got no visibility.

What I would like to see next is more awareness among SMEs. Having evidence to answer questions like what is it, why should I do it and what is the return on investment of Industry 4.0. I would also like to see some frameworks or standards to help analyse and visualise data more effectively; putting processes in place and preconfigured approaches."

Jonathon Shaw, chief engineer, digital manufacturing, Manufacturing Technology Centre

"What Industry 4.0 says to me is that data is value. It will allow us to transform business, to customise products in a far greater way, it's going to improve performance and have impact on society.

One of the main challenges is how you capture what you're learning about the new processes. We employ approximately 250 engineers who work in that innovation zone between research and commercialisation and we're looking at

how we capture all the knowledge they're learning, embed it and keep it within the business.

What needs to happen next? There needs to be evidence that the UK at a national level has a strategy and a vision of what we want to do as a nation. To its credit, the government is funding the High Value Manufacturing Catapult to start to look at what that national strategy is and the role the Catapult can play within it. Within the HVM catapult, we have a role to play to tackle the barriers. Awareness is a huge problem; I don't think that those buried deep in the supply chain are aware of what Industry 4.0 can offer. We have a key role in educating people, showing industry what the possibilities are and minimising their risks. We help companies to roadmap their journey and understand what success looks like. For every challenge, I know the MTC will want to play a role in breaking down the barriers. But it's too big for any one single organisation to address."

Appendix 2

Copies of the interview transcripts for:-

- LJMU ETRI : Magnex
- LJMU ETRI : Beverston Engineering
- LEP : Brainboxes
- LEP : LPW Technology
- VEC:AQR Hemsted Ltd
- VEC:Quaws
- Hartree : I Gardner

Needs & Demand Report

9.1 One to One Interview Questions

Name	Maurice Dempsey	Position	Director
Organisation	Magnex	Date	5th September

Within your business, what would you like to do? *For example:-* • *Increase efficiency* • *Increase productivity* • *Reduce costs* • *Develop an idea* • *Improve existing products* • *Develop a new product* • *Develop a new process* • *Strengthen your position in the supply chain*
Develop a new product – using the virtual prototype to attract potential buyers and investors, test and develop an actual prototype and validate the technology. Eventually taking the product to market.
And do you know how you will do this?
Virtual reality element has already attracted interest in another direction – virtual gaming. Need an engineer to develop the physical prototype. Require funding or investment to pay to develop physical prototype, attracting investment via equity. As an SME, it would be too difficult to lend money via banks.

What or who is the main driver for you to undertake product/process development? *For example:-* • *Customer/supply chain* • *Your idea/passion to innovate* • *Identify a gap in the market*
Passionate to be innovative, have identified a gap in the market, existing fitness machines are not technically affective.

How often do you seek to develop new products?
Experience in the past of introducing new products every 4-5 years. But with this product would be continually developing to enhance the machine.

Do you require any expert help to develop your ideas and new products? *If so, do you know what type of support you require?*
Yes – engineering, software and sensor technology

What are the main challenges and or barriers you face to innovation or new product development? *For example:* • *Lack of clear vision and support/leadership* • *Funding/investment* • *Unclear economic benefit from investment* • *Finding the right partners for development* • *Lack of external support* • *Timescales* • *Lack of knowledge* • *Skills* • *Concerns around loss of control of your IP* • *Testing/Validation of prototype/product* • *Access or knowledge of market* • *Exploitation and commercialisation strategies*
Money – lack of funding and investment. More knowledge *Concern around losing control of your idea and development of machine. IP* *Testing and validation – LJMU Sports Science* *Exporting* *Demonstrations and early adopters – key influences – LFC and EFC Football* *Technical support from LJMU*

Do you have any plans or strategies in place? • Business Improvement strategy • Business Plan • Business Growth Plan • Innovation Strategy • Marketing Strategy • Change Management Process How often do you review your strategies? How often you undertake a business review? What has been the impact of the implementing the strategies?
Business Plan – always changing Pitch Deck – investment – power point Video to promote Marketing strategy is to go to the key players with the prototype to get feedback from potential buyers/customers Need an investment strategy Continuous review process. Not really in business yet, only look a different ways of funding the development. The impact of the strategies has been – investment opportunity have been considered and not satisfactory, reviewing different crowd funding option and shareholding options.

What is your understanding of Industry 4.0 technologies? What is your understanding of digital technologies – Data & Analytics as core capability? 1. *Digitisation and integration of vertical and horizontal value chains* 2. *Digitisation of produce and service offerings* 3. *Digital business models and customer access*
It is all new to me – virtual prototype, sensor technologies, software development. Wireless body networks, sensors, Apple Watch, Fit Bit that links data. What do I think it is – you tell me!

Needs & Demand Report

9.2 One to One Interview Questions

Name	Rod Wah	Position	Managing Director
Organisation	Beverston Engineering	Date	23rd September 2016

Within your business, what would you like to do?

For example:-

- *Increase efficiency*
- *Increase productivity*
- *Reduce costs*
- *Develop an idea*
- *Improve existing products*
- *Develop a new product*
- *Develop a new process*
- *Strengthen your position in the supply chain*

All – increase productivity, reduce waste, increase efficiency, reduce costs, continually re-calibrate as things move on, can't stand still. Doing well at the moment but basically be prepared for the next challenge. Constantly evolve.

New products are different for us, get the drawings from the supplier, but new manufacturing techniques will assist i.e. 3D printing etc. Buy Mazac machine tools additive manufacturing but aerospace is very slow, analyse for safety reason, very slow process before approving the new technologies.

And do you know how you will do this?

It's the unknown and this is where LCR 4.0 project is of interest, need to learn of new processes, get knowledge & expertise from outside the company into the workforce. Constantly upskilling the workforce.

Machinists are not just machinists, need to be able to use all aides and are training people up to use the new technologies at the moment.

What or who is the main driver for you to undertake product/process development?

For example:-

- *Customer/supply chain*
- *Your idea/passion to innovate*

- *Identify a gap in the market*

Customers do dictate and my own ideas as well.

How often do you seek to develop new products?

Don't really, don't design, make the customers parts for them.

Do you require any expert help to develop your ideas and new products?

If so, do you know what type of support you require?

Upskilling the workforce to have the ability to adopt the new technologies and be aware and understand the customers' requirements. Be aware of your competitors and what they are doing that you are not.

What are the main challenges and or barriers you face to innovation or new product development?

For example:

- *Lack of clear vision and support/leadership*
- *Funding/investment*
- *Unclear economic benefit from investment*
- *Finding the right partners for development*
- *Lack of external support*
- *Timescales*
- *Lack of knowledge*
- *Skills*
- *Concerns around loss of control of your IP*
- *Testing/Validation of prototype/product*
- *Access or knowledge of market*
- *Exploitation and commercialisation strategies*

Always looking at new ways to improve the business.

Adapt to what everyone is doing, involved in new products but they will have been designed for us. Get involved in the testing and validation i.e. new materials come along and don't know how to cut them/machine them. Lack of knowledge, skills, time restraints, funding, if we solve the problem – invest – they will give you the contract – taking on the risk.

Methods of manufacturing that can produce good parts can take a while to develop, can

claim tax relief for R&D.

Interested in any collaborative partnership – particularly grinding any new R&D projects be interested in.

Do you have any plans or strategies in place? • Business Improvement strategy • Business Plan • Business Growth Plan • Innovation Strategy • Marketing Strategy • Change Management Process How often do you review your strategies? How often you undertake a business review? What has been the impact of the implementing the strategies?
Continuous Improvement Plan Change Management Process – Supply Chain 21 – Bronze level (run by ADS collaboration run by all the top aerospace BAE, Rolls Royce, measure your performance) No business plan, but develop as we go along New processes and software Pre Product Introduction Procedure – analyse, what can go wrong, reducing manufacturing processes and ensuring good products with minimal costs.

What is your understanding of Industry 4.0 technologies? What is your understanding of digital technologies – Data & Analytics as core capability? 4. *Digitisation and integration of vertical and horizontal value chains* 5. *Digitisation of produce and service offerings* 6. *Digital business models and customer access*
Very limited, but understand it is the next big change in manufacturing and what that means – who knows. Imagine it is digital manufacturing processes. Other than 3D printing, not much is changing in machining. Limited to do one rather than mass production. Aware that the current machines may end up outdated and it will take a lot of time.

9.3 LCR 4.0 Expert Interviews

Name:	Luke Walsh	**Position:**	Managing Director
Organisation:	Brainboxes		
Country:	UK	**Date:**	4th October 2016

Summary

Established in 1984, Brainboxes is one of the leading serial communication device developers and manufacturers in the World. With headquarters in Liverpool, UK, it has a team of highly qualified software and hardware designers, matched by a world-class in-house volume manufacturing facility and a global distribution chain. Brainboxes mission is to provide innovative data communication products to ensure customers can "Connect, Configure and Control" their serial devices.

Interview

Within your business. What would you like to do?

LW: Essentially, we would like to continue developing cutting edge products, particularly for production lines where the conditions may require more heavy duty solutions than other providers offer in the market. We would also like to secure our relationship with customers by improving our service offer – for example, offering the best machine monitoring solution to enable the customer to minimise downtime when a part breaks.

…and do you know how you will do this?

LW: We have a clear vision – we want to be keep our reputation for reliability because that is what will drive business. Making sure that our products are able to interact with other systems, both new-to-market and legacy, means adapting our products for different platforms, languages, clouds and so on. This means focussing on software as well as hardware.

What is the main driver for you to undertake product/process development?

LW: Definitely the customer, and wanting to keep their custom. We upgrade our customers' existing hardware as well as supplying new customers. This ties in to us always seeking to improve our products and therefore enhance our market standing.

How often do you seek to develop new products?

LW: On average we create 1 per month, which are modifications of existing products. We have 1 entirely new product roughly each year. There are so many routes we could go down in the market because of all the hype around 'Industry 4.0' and industrial connectivity at the moment. Finding the right collaborative partners can be a challenge, because there is a tendency for businesses to overstate their credentials in the IoT and IIoT field. One success with collaboration we have had

recently however has been with IBM's software integrator 'SRO', working on plug and play products for harnessing machine data.

Do you have any plans or strategies? If so, how often do you review them? Have you seen an impact from them?

LW: We have several in place around marketing and growing the business. Typically, plans are yearly in nature and reviewed quarterly. It is important, however, that we are agile and can adapt to changes in our market or customer landscape – this links in with the idea of continuously improving our products and winning business with smaller companies.

What is your understanding of Industry 4.0 technologies?

LW: We are an enabler for Industry 4.0, but also we are always looking to use it within our own operations to increase productivity and create new business. We have looked at moving up the value chain, but as it stands, 4.0 is too big for a single company to 'do everything' and offer a single integrated solution. We know what we do best [hardware] and we want to keep doing that to the best possible standard. We do this by being customer-led and giving them a Plug 'n' Play solution which meets most of their needs straight out of the box. We can then refer them to our collaborative partners to fulfil their other needs where appropriate.

This interview was conducted by Jonathon Clark, LCR LEP, UK

9.4 LCR 4.0 Expert Interviews

Name:	Phil Carroll	**Position:**	Managing Director
Organisation:	LPW Technology		
Country:	UK	**Date:**	21st September 2016

Summary

Established in 2007, LPW Technology Ltd is a market leader in the development and supply of specialist metal powders and powder lifecycle solutions into the 3D printing, metal Additive Manufacturing (AM) industry. LPW is certified in ISO 9001C, AS 9100 and AS 9120A as well as ISO 13485. In July 2016 they received a Queen's Award for Enterprise in International Trade, a reflection of the success of their over 90-strong Runcorn HQ branching out with offices in the USA, Germany, Italy and the Far East. LPW brings together exceptional industry and technology knowledge to develop applications and specialist materials particularly for the high-tech aerospace, automotive and medical industries.

Interview

Within your business. What would you like to do?

PC: Due to the paperwork required in the aerospace industry, we are still quite paper-based. We would love to go as paperless as possible to not only be a more environmentally friendly company, but to have foster a culture of real-time information handling in the company. We have just implemented a new ERP system and would like to squeeze every drop of value out of knowing exactly where something is, what it is, where it's going etc…

…and do you know how you will do this?

PC: We are experienced in the field of software – it comes with the territory of producing the highest quality AM powders to industries with stringent safeguards in place. We already know that data is important, particularly in our field which is R&D heavy, so we envision that working with data scientists at somewhere like the Hartree centre would boost our in-house development and analytics

What is the main driver for you to undertake product/process development?

PC: The industries we supply to constantly develop new products to sell to consumers. They are also having to meet strict safety requirements, for example, so in order to retain our place in that supply chain we have to adapt our products and processes accordingly. We also want to be the supplier of choice to businesses, so that means outperforming our competitors. In the fast-expanding field of AM, this means pushing new boundaries and trying new things. If you don't, you'll be left behind – it's that simple.

How often do you seek to develop new products?

PC: It's constant – we are constantly refining, improving and exploring new ways to tweak products. It is essential in our field of work, not only to stay that extra inch ahead of the competition but to continually deliver products which meet the highest expectations.

Do you have any plans or strategies? If so, how often do you review them? Have you seen an impact from them?

PC: Coherent strategy is essential. We have plans and strategies around business improvement, growth and innovation, as well as other aspects of the business. We review them in practical terms between 3 to 6 months because of the pace at which this industry develops at. We are in a strong position in our market.

What are the main challenges and/or barriers you face to innovation or product development?

PC: IP. I cannot stress enough the need for protection of our intellectual property – it is so important. We also need to have full traceability of our powder materials – which machine, operator, powder batch has it gone through? This is so fundamental to what we do as a business, that we have to bear it in mind whenever we look at anything to do with product development or new innovation.

What is your understanding of Industry 4.0 technologies?

PC: In many ways, we've been doing 4.0 for a while – many people say AM itself is one of the big components of 4.0. It's important to not just follow the hype. So much of what we do is around making the most of data and it is common sense to maximise profit and minimise costs, so I would say we are making it a reality and it runs through our business.

This interview was conducted by Jonathon Clark, LCR LEP, UK

Needs & Demand Report

9.5 One to One Interview Questions

Name	Peter Kukla	Position	Managing Director
Organisation	AQR	Date	12/10/2016

Within your business, what would you like to do? *For example:-* • *Increase efficiency* • *Increase productivity* • *Reduce costs* • *Develop an idea* • *Improve existing products* • *Develop a new product* • *Develop a new process* • *Strengthen your position in the supply chain*
Increase efficiency, reduce costs, develop a new process, develop a new product
And do you know how you will do this?
Yes

What or who is the main driver for you to undertake product/process development? *For example:-* • *Customer/supply chain* • *Your idea/passion to innovate* • *Identify a gap in the market*
Customer/supply chain, identify a gap in the market

How often do you seek to develop new products?
Annual targets

Do you require any expert help to develop your ideas and new products? *If so, do you know what type of support you require?*
Modelling/CFD expertise, high voltage electrical expertise (barrier discharge)

What are the main challenges and or barriers you face to innovation or new product development? *For example:* • *Lack of clear vision and support/leadership* • *Funding/investment* • *Unclear economic benefit from investment* • *Finding the right partners for development* • *Lack of external support* • *Timescales* • *Lack of knowledge* • *Skills* • *Concerns around loss of control of your IP* • *Testing/Validation of prototype/product* • *Access or knowledge of market* • *Exploitation and commercialisation strategies*
Funding/Investment, finding the right partners for development, IP protection, testing and validation of product/prototype

Do you have any plans or strategies in place? • Business Improvement strategy • Business Plan • Business Growth Plan • Innovation Strategy • Marketing Strategy • Change Management Process How often do you review your strategies? How often you undertake a business review? What has been the impact of the implementing the strategies?

Business plan, innovation strategy and marketing strategy in place. Strategies are reviewed at least quarterly. Ongoing business reviews. AQR already attracted 2 major industry clients.
What is your understanding of Industry 4.0 technologies? What is your understanding of digital technologies – Data & Analytics as core capability? 7. *Digitisation and integration of vertical and horizontal value chains* 8. *Digitisation of produce and service offerings* 9. *Digital business models and customer access*
No knowledge about industry 4.0 technologies.

Needs & Demand Report

9.6 One to One Interview Questions

Name	Dr M'dimoir Quaw	Position	Researcher
Organisation	"Quaw's"	Date	2nd November 2016

Within your business, what would you like to do?

For example:-

- *Increase efficiency*
- *Increase productivity*
- *Reduce costs*
- *Develop an idea*
- *Improve existing products*
- *Develop a new product*
- *Develop a new process*
- *Strengthen your position in the supply chain*

Develop an idea, Develop a new product, Develop a new process, Strengthen your position in the supply chain

And do you know how you will do this?

I have analytically generated a mathematically-sound physics model in the thermal efficiency enhancing unit (TEEU). However there are a few potentially adverse physical processes that can render it unsuccessful. Computer modelling taking into account all significant processes (optimistic and pessimistic) will allow my business to know if TEEU design and manufacture are productive, before funds and time are wastefully invested.
If the net computational result is optimistic, then design of a product can take place. "know how" optimal manufacturing techniques for additional intellectual property (IP) control can be processed. Computational knowledge of TEEU capability will allow QUAW'S to ascertain the position of TEEU in terms of power capacity, operating temperature and therefore energy market placement on the supply chain. Computational simulation is crucial. All other paths would be a potentially expensive and time-wasting "shot in the dark".

What or who is the main driver for you to undertake product/process development?

For example:-

- *Customer/supply chain*
- *Your idea/passion to innovate*
- *Identify a gap in the market*

The gap in the market and customer are the main drivers (Increased energy efficiency, power shortage, and inexpensive power). My idea is a competitive means to plug said gap for the customer. My passion to innovate motivates me to make the idea competitive through research and development.

How often do you seek to develop new products?
QUAW'S has five key concepts in the power and propulsion sectors (of which TEEU is only one). These concepts each comprise of tens of subcomponents required to realise said concepts. QUAW'S holds approximately sixty patents over its six years of operation averaging at ten conceptual or product upgrades per year in total. The more successful QUAW'S is, the more it can afford to innovate and seek computer simulation validation and product manufacture.

Do you require any expert help to develop your ideas and new products? *If so, do you know what type of support you require?*
For most of QUAW'S concepts and new products, low vacuum technologists are required for aerospace applications. This seems to be a common feature of QUAW'S technologies to greater or lesser extents. For TEEU, particulate thermal radiation ablation in a vacuum is a first step. Other concepts require expertise in high-current electrical (power) circuits, basic antenna modelling for the remote beaming of electrical power, astrophysical (solar wind and ionosphere) plasma modelling, subsonic and hypersonic atmospheric flow for aerospace applications, terminal ballistic analysis at supersonic and extreme hypervelocity impacts, and neutron shielding for nuclear power applications (For example, can TEEU be safely operated in a nuclear power plant without undergoing neutron contamination?) .

What are the main challenges and or barriers you face to innovation or new product development? *For example:* • *Lack of clear vision and support/leadership* • *Funding/investment* • *Unclear economic benefit from investment* • *Finding the right partners for development* • *Lack of external support* • *Timescales* • *Lack of knowledge* • *Skills* • *Concerns around loss of control of your IP* • *Testing/Validation of prototype/product* • *Access or knowledge of market* • *Exploitation and commercialisation strategies*
• *Funding/investment* • *Finding the right partners for development* • *Lack of external support* • *Timescales (this is alleviated by funding, external support and partners)* • *Lack of knowledge (this is alleviated by partnership and external support to cross-*

check and clarify my suppositions)

- *Skills (Computational simulation and manufacturing are required)*
- *Concerns around loss of control of your IP (Although UK patent filing is often done, getting partners interested in developing a product for the global market is required; and for this, US patent protection and US-savvy business partners are required)*
- *Testing/Validation of prototype/product (require external help, funding and partners to take time to develop a prototype)*
- *Access or knowledge of market (The market is always on my mind when developing concepts. Finding partners to get from concept to market is the great barrier)*
- *Exploitation and commercialisation strategies (The concepts are designed for maximal commercial leverage, but in general, I have little support and can only afford to conceptualise and seek partners).*

Do you have any plans or strategies in place?

- Business Improvement strategy
- Business Plan
- Business Growth Plan
- Innovation Strategy
- Marketing Strategy
- Change Management Process

How often do you review your strategies?

How often you undertake a business review?

What has been the impact of the implementing the strategies?

- Business Plan (yes)
- Business Growth Plan (develop concept to product with help of an industry partner)

What is your understanding of Industry 4.0 technologies?

What is your understanding of digital technologies – Data & Analytics as core capability?

10. *Digitisation and integration of vertical and horizontal value chains*
11. *Digitisation of produce and service offerings*
12. *Digital business models and customer access*

Digitisation of produce and service offerings: Computer simulation of physical processes, optimisation of technological design, and estimation of performances. Once a working model can be manufactured from the simulation data, potential clients with their requirements can be serviced by using simulation parameters to design bespoke TEEUs for their applications.

9.7 Hartree : I Gardner

Background/Introduction

Ian Gardner, IBM now part of SMD division in IBM, many years in global consulting services and PWC before that. Implementing complex solutions and projects for ERP systems in businesses (tend to be large scale, complex projects). Within my S&D role, my main role has been looking at CritSits (critical situations??) and some of the bigger problems and competitive issues as an advisor for our Hardware advisor on Oracle related competitive situations, to understand the workload rather than just the technology itself.

A while ago, I started looking at an Industry 4.0 project, implementing Industry 4.0 for Meggitt PLC, working as a consortium with AMRC, MTC, Meggitt PLC and Innovate UK. To make Industry 4.0 a reality for Meggitt, very complicated but also quite unique – I know a lot of people say they are "at" Industry 4.0 but the levels that people are at is usually pretty thin. Whereas, at Meggitt, we are looking to do something that's real and tangible. It's a proof of concept, running until 2018 and it's "all" working! It's not in a real business situation yet, it is a proof of concept, but the idea is that the findings from that will move into a real case scenario but obviously it's got to prove the business case, which is quite challenging.

But you've got real world experience of Industry 4.0 implementations; why they're doing it, what the results aim to be and what the challenges are behind it?

It's quite interesting really, Industry 4.0 as much as you look at it from a technological perspective, technology has given it the potential to happen, it has always been possible but the economics of it made it not viable, whereas now you can pick up bits of kit for next to nothing. The technology seems to be very much the easy bit, in my view, the complicated bit is how you actually string it all together and the design of that. Because what you find is that the lifeblood of your industry is the data rather than the machines, the business processes because all of those are hinging on information that's being passed around. That information is creating decisions, forcing decisions and that's very different – because we've always had that before but it's kind of been "back office" and now it's moving onto the shop floor. It's exciting!

So within Meggitt for example, what was their key focus of the project, was it efficiencies, improving a process/productivity etc.?

It was a number of things. Efficiency was obviously a key driver but one of the big challenges for Meggitt was that they have an ageing workforce, which is a challenge in itself, and they need to replace that workforce as they retire. I think the average age is 55 and it takes 7 years to train someone up and they retire at 59 on average so they've got a problem there. But also they work in low volume, high complexity manufacturing so what you find is a lot of things that they make, they're having to "dust off the manuals" to understand how they're made, which isn't a problem, it just lacks efficiency. Also, because they work in aerospace, there is high demand for traceability and

Industry 4.0 can support that. There's also a need for high quality products, which takes you back to skills etc. And they need to create more efficiency because their factories aren't mass production, it's more like a hospital or a lab where people take their time to create things because it's got to be right first time. So they've called their solution M4: Meggitt Modular Modifiable Manufacturing and they're championing this.

Are they actually developing any new products out of it or just looking at their current deliverables and trying to make them more efficient?

Well, their industry (aerospace) doesn't move at the pace of some manufacturing, a lot of the planes that they are making parts for are in the sky for 40/50 years and they're expensive to develop so yeah they'll be new things coming along e.g. technology changes in the materials used and manufacturing methods but I4 isn't really about that, it's about the way decisions are made, managing the entire production line versus new goods.

And you're obviously involved in the project as "IBM"…so what's in it for you?

I don't know, it's just really interesting isn't it? Its exciting stuff, the next generation of technologies and capabilities. Also, when I look at my ERP past, before when you were looking at ERP systems, the whole benefit of that was to bring everything together so there was this full integration. And this is taking that a level further, so it fits well.

My hope is that this work builds into new work, more work, not when it finishes but concurrently. New opportunities, new chances to develop the knowledge that we've gained from this and expand on the technologies we've got so that we can start pushing that out and commercialising it. There's huge opportunities, everyone is talking about Industry 4.0 so IBM needs to get involved; be it selling services or technology or whatever and being involved in projects like the one with Meggitt, gives us the credibility.

What do you see as the main challenges or barriers to Industry 4.0 adoption?

A fear. Because it can be quite daunting. People don't know what their capabilities are, I was at the Factory 2050 event a few weeks ago and that was interesting because I spoke to a number of organisations who were saying "well we can't do this because most of our operations are manual" but look at all the manual processes in Meggitt that AMRC are looking at, at the moment and there are ways of bringing them into Industry 4.0 so that's not a showstopper, there are ways round that. Quite easy ways, without spending lots of money and not replacing people with robots, you're just adding that data connection so that you can control things e.g. smart tools rather than a wrench. Its only limited by your imagination and lack of understanding.

There is also a lust to "jump on the bandwagon" without knowing what the use case is. There needs to be a business case and if you're not clear on that then you'll never see the benefits from the adoption.

So support on strategic direct is key. What about funding issues? Especially for the likes of SMEs.

I think there is a lot of interest, both from business and from government, but funding is a challenge for everything so I don't think this is any different but it is probably in a better place than most because it's at the top of the agenda. It was on the Davos (World Economic Forum Annual Meeting) agenda so it's getting all the headlines so I don't see it as a blocker.

A key thing as well is making these things into enterprise class solutions. What I mean by that is ensuring they have resilience, so when you're the production manager/CEO etc. of a particular site, it's what keeps you awake at night because the machines are dying or the infrastructure or I4.0 solution that's driving that site doesn't have the resilience to perform at an enterprise level. People need to consider that when they look at implementation because a lot of these solutions are "hobby-type" developments that aren't designed for big business capability.

Speaking as IBM then, do you have any strategies in place with regards to Industry 4.0?

Well we've put a lot of money, time and resources into the PoC with Meggitt so we hope that that will bring with it, new opportunities and new customers. So yeah, strategy going forward; we've got new business leaders in that area.

What's your understanding of data and analytics as a core capability for Industry 4.0?

It's essential – what's the point in capturing loads of information if you can't make decisions from it? So yeah, it's a key component, the tool in the sensors is capturing the information but the analytics should be able to decipher that to make decisions. This is where the fun starts because you can have rule based decision making (IF...THEN), pretty basic been around for years, or the fun stuff is interpreting it into predictive maintenance and tech like cognitive tech and there's a big option in the marketplace for thinking systems like Watson – replicating the intuition, knowledge and understanding of the workers who have been doing the tasks for X number of years.

The other thing is the nature of databases, using the unstructured databases now that can handle much more data and have improved performance over traditional structured databases. So you can analyse and visualise and send commands to the machines from the information, so the whole environment has changed.

Analytics is also a big problem too. If you look at scenarios and what you need to do to enable Industry 4.0, the technology stuff is quite simple but what's complicated and takes all the time is defining what the logical data models are to make sense of the data, and that's the tough job.

And that's where you see businesses needing specialist support?

Yes, to bring it all together so that people understand what information they need, what it's going to mean and so they can get value from whatever solution they're putting in. Building that model is the hard bit.

And do businesses know that's what they need, in your opinion?

Well you've only got to look at historical projects and where they went wrong to see that its usually in the upfront planning in the beginning. There's an education piece needed because we don't want people just buying sensors and capturing information but maybe not the right information or unable to access it to make decisions. To go forward we need to take a step back.

What is your understanding of digital business models and customer access?

In ERP systems, there was a kind of revolution where you've got B2C and B2B and you can suddenly give access to your customers and your suppliers to your production planning, so now your supplies were arriving exactly when you needed to meet the customer demand. Not rocket science, but a revolution in system access; rather than having a broker in the middle, they (suppliers) were fully engaged with no latency and similarly for customers, you were integrating all the orders. This is commonplace these days – getting texts/emails to track orders etc.

Slightly different for Industry 4.0, you're not giving access just to "general" information, you're giving access to the actual machines and information as to how something has been made. That brings with it a lot of benefits, but also a lot of risks because you're essentially hanging your dirty washing out for all to see! It's good for traceability, it's good for people's confidence in what's happening, it's good for maintenance (in that if you've got a machine there with lots of upcoming work, you can bring maintenance schedules forward to prevent incidents). But security concerns are massive, because, particularly in aerospace, really critical manufacturing where there's lots of IP, all your methods of doing something are going to be exposed to the world and it needs a lot of thought about security and how you're going to ensure access to the correct information only. You don't want to put your USP at risk to hacking, so security is a big problem for consideration. It's not impossible though.